PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

PLANTERS' BULLETIN FIFTY-TWO

SPECIAL CONFERENCE ISSUE

Proceedings sent for C to R. Newham

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CORRESPONDENCE. All LETTERS must be addressed to the Director, Rubber Research Institute of Malaya, Post Office Box 150, Kuala Lumpur. Special enquiries may be marked for the attention of particular officers. The address for TELEGRAMS is Searching, Kuala Lumpur. TELEPHONE: Kuala Lumpur 72051. PARCELS occasionally arrive without any indication of their origin. Senders' names and addresses should be written clearly on the outside of all packages, and advice of despatch should be given by letter or telegram.

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ADVICE. Enquiries are invited from rubber producers in the Federation of Malaya, Singapore, the colony of North Borneo, and the territories of Sarawak, Brunei and Nigeria, who may require more detailed information applicable to their own special problems. Where it is considered necessary, visits will be made to estates in Malaya as convenient. Visits to estates in other territories are by special arrangement The only visits for which charges are normally made are those of our clone indentification inspectors. INTERVIEWS should be arranged by letter, as members of the senior research and advisory staff are frequently absent on visits to plantations.

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PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

Kuala Lumpur | January 1961 | Number 52

Summaries of the Proceedings of the Natural Rubber Research Conference, Kuala Lumpur, 1960

The present issue is almost entirely devoted to the publication of summaries of the papers presented at the Conference, including the three scientific papers at the General Sessions and the closing address by Sir Geoffrey Clay.

The abstracts are intended to give readers a general picture of the work of the Conference and of present trends in rubber research. For this reason all the papers presented receive some mention. Papers of the more 'fundamental' type, which have no immediate bearing on the work of the practical planter, are represented by short abstracts and in some cases by titles only. At the Conference, all papers were followed by discussions which will appear in full in the printed *Proceedings*. An excerpt from one of these discussions, which is felt to be of special interest to our readers, is reproduced here.

The abstracts follow the same order as the papers in the Conference itself, and, again as in the Conference, are divided into three main groups: 'General Sessions', 'Natural Rubber Production' and 'Preparation and Use of Natural Rubber and Latex'. The sub-division of these main groups into sessions on specialised subjects is shown in the Guide to Summaries overleaf.

The publication of these summaries represents a departure from the normal policy of *Planters' Bulletin*, which is, in general, to publish only 'firm recommendations' based on accumulated evidence from research; the Rubber Research Institute of Malaya does not necessarily concur with the views expressed in the summaries which follow. It is in the nature of a Conference that many of the opinions expressed should be exploratory rather than firmly based and, in a few cases, frankly unorthodox. We nevertheless hope that our readers will welcome this opportunity to 'look behind the scenes' of rubber research and to consider how current investigations may influence established practice in the future.

A note on the publication of the printed *Proceedings* appears at the end of this issue.

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GENERAL SESSIONS

General Sessions

These Sessions are to be given in full in the printed *Proceeding*. The summaries below are restricted to accounts of the three scientific papers by guest speakers and the address by Sir Geoffrey Clay at the Closing Session in which he reviewed the work of the Conference.

The biogenesis of rubber. PROFESSOR JAMES BONNER, Division of Biology, California Institute of Technology

In 1949 it was discovered that a Mexican plant, guayule (*Parthenium argentatum*), could form rubber from acetic acid molecules. Since then the same process has been found to operate in all other rubber-containing plants examined, including *Hevea brasiliensis*.

Research has also revealed that acetic acid molecules are the building units for all the substances called 'isoprenoids'. These make up a great group of natural products which includes rubber, terpenes, sterols and carotenes. The molecules of the isoprenoids are made up of 5-carbon units. Hence the first steps in rubber biosynthesis, and in isoprenoid synthesis generally, are concerned with the building of a 5-carbon unit from the 2-carbon acetate molecules. This takes place through a long chain of intermediate substances most of which have now been identified. Thus acetate molecules are converted to acetyl co-enzyme A and then built up to β-methyl-β-hydroxy glutaryl co-enzyme A, which contains six carbons derived from three acetate units. This is converted in turn to mevalonic acid, a key compound in the sequence, which still has six carbon atoms. Next, mevalonic acid is phosphorylated, it loses one carbon atom as carbon dioxide and the product, isopentenyl pyrophosphate, contains five carbon atoms. This is the actual unit which can be polymerised to isoprenoids, including rubber.

The exact mechanism by which isopentenyl pyrophosphate is polymerised in the tree to give rubber is not yet known, but is under study and rapid advances in knowledge are to be expected. Indeed, the vital steps leading from acetate to isopentenyl pyrophosphate were themselves discovered only in the last four years.

The stimulation of latex flow by plant growth regulators. PROFESSOR G.E. BLACKMAN, F.R.S., Sibthorpian Professor of Rural Economy, Oxford University and Director, Agricultural Research Council Unit of Experimental Agronomy

The successful development of yield stimulant mixtures containing 2,4-D and 2,4,5-T is described against the background of research into the properties of plant growth regulators.

In a series of experiments commencing in 1956, the effects of a large number of growth regulators on yield and bark renewal have been investigated. There is usually a close correlation between ability to stimulate latex flow and the production of renewed bark of increased thickness. The relative activities of the different compounds are discussed;

one of possible commercial interest is 2,4-dichloro-5-fluorophenoxy-acetic acid (2,4-C-5-FPA). There is also a discussion of the possible mechanisms whereby yield stimulants may act.

A conservative estimate of the additional weight of rubber produced in Malaya from 1956 to 1959 by the use of yield stimulants is 68.4 million pounds, valued at 63 million Malayan dollars. Even halving this estimate, we are still left with a handsome return for the money spent on research.

Looking ahead, new problems are arising; in particular, the possible uses of yield stimulants on younger high-yielding trees. Patient and pertinacious research will be required to find the answer to these questions.

New methods of elastomer synthesis and their impact on natural rubber. PROFESSOR G. GEE, C.B.E., F.R.S., Sir Samuel Hall Professor of Chemistry, University of Manchester

A polymer is formed by joining together a number of units, namely the monomer molecules. In the natural rubber polymer a large number of isoprene units are combined to give a long chain molecule. There are however six different ways of joining two isoprene molecules together, somewhat reminiscent of the six ways of laying a brick, and the properties of natural rubber depend on the fact that each unit is joined to the next in exactly the same way.

Recently, new methods have been developed which enable this same regularity to be achieved when polymerising synthetic isoprene. The same methods can be used to produce other stereoregular polymers e.g. polybutadiene.

These new polymers offer a severe challenge to natural rubber. There are still difficulties to be overcome in processing and vulcanisation, but they are almost certainly not insuperable.

Natural rubber is, however, an elastomer having very good properties. It is predicted that the expanding total demand for elastomers will ensure full utilisation of the increasing supplies of natural rubber—provided that fundamental scientific study and technological development are vigorously pursued, so as to improve quality and reduce cost of production.

Address at the Final Session of the Conference. SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C., Controller of Rubber Research and Chairman of the Malayan Rubber Fund Board.

A summary was given of the work of the Conference as a whole. In the field of natural rubber production, particular attention was drawn to the advance made in yield stimulation, the vegetative propagation of *Hevea*, the study of leaf and latex analysis as a means of assessing nutritional requirements, correction of minor element deficiencies, the use of cover crops and the control of root disease. It was pointed out

that current research into the biosynthesis of rubber in *Hevea* might well have an important bearing on rubber production in the future.

In the sessions on the preparation and use of natural rubber and latex there were important papers covering fundamental research into the properties of latex and the structure of the rubber hydrocarbon. Bacterial attack on latex and its control by preservatives were discussed at length. Other papers of special interest dealt with clonal influence on latex foam properties, and with tests for assessing the quality and processability of latex concentrate. Several papers covered the improvement and standardisation of dry rubber in its many forms and the production and use of Superior Processing rubbers.

After reviewing the work of the Conference, Sir Geoffrey described the recent reorganisation of the administration of rubber research in Malaya.

NATURAL RUBBER PRODUCTION

Nutrition I

The effect of fertilisers on pH and the exchangeable cations of some Malayan soils. J. BOLTON, The Rubber Research Institute of Malaya, Kuala Lumpur

The substance of this paper has already been published in *Planters' Bulletin 50,* page 98.

Manuring of rubber in relation to wind damage. E.A. ROSENQUIST, Director of Chemara Research Station, Seremban, Malaya

The susceptibility of a rubber tree to wind damage is affected by many factors. These include the local severity of storms, clonal characteristics, spacing, time of opening, intensity of tapping and manurial policy.

Data from manurial trials have been used to study the effect of fertilisers on wind damage. Damage is correlated with high leaf nitrogen, high leaf phosphate and low leaf potash.

An attempt has been made to relate these conclusions to physiological variations in the rubber tree. Tentative conclusions are as follows.

Heavy dressings of nitrogen lead to high individual leaf weight and heavy crowns. This directly increases susceptibility to wind damage.

The simple products of photosynthesis are used for the production of protein on the one hand and lignin and cellulose on the other. Protein formation is particularly dependent on nitrogen and phosphate, whilst lignin and cellulose formation is particularly dependent on potash. High nitrogen and phosphate levels favour protein formation and new growth at the expense of lignin and cellulose formation. This leads to weak wood.

Heavy applications of sulphate of ammonia to rubber reduce leaf potash. Potash deficiency in other crops leads to weak fibres and poor sclerenchyma formation. Wood from potash deficient rubber tends to be weak.

To reduce susceptibility to wind damage the manurial policy should err on the side of low nitrogen and high potash — and probably low phosphate and high magnesium.

Inconsistencies in the response of Hevea brasiliensis to phosphatic fertilisers in field trials and in pot experiments with soil. K.R. MIDDLETON, The Rubber Research Institute of Malaya, Kuala Lumpur

This paper discusses evidence which exists for considering rock phosphate to be as effective a fertiliser in Malayan rubber plantations as superphosphate, whereas for a wide range of soil and climatic conditions in other countries superphosphate has been found superior.

An investigation of this anomaly has however shown that under the controlled conditions of a pot experiment better growth of rubber seedlings can be obtained with superphosphate than with rock phosphate. Some results from pot experiments also suggest that, though the four-ounce planting-hole application commonly used for rubber in Malaya

is near the optimum for rock phosphate, too much soluble phosphate is supplied if superphosphate is used. In addition to retarding growth, excess soluble phosphate can induce (or aggravate) certain minor element deficiencies in the soil and so cause additional interference with plant nutrition.

A new method for diagnosing nutrient element deficiencies is briefly described. Preliminary results with this method suggest that multiple deficiencies (or near deficiencies) of minor elements may occur in some Malayan soils. Such deficiencies could limit the response to major fertilisers without producing easily recognisable visual symptoms in the plants. More information on such occurrences should help to explain puzzling results obtained in fertiliser trials, such as the ones mentioned in this paper.

Contribution to the study of boron in the rubber tree (In French). J. Cocchi, Institut des Recherches sur le Caoutchouc au Vietnam

Statistical analysis of the leaf analyses has demonstrated a correlation between boron and potassium.

A field experiment with different micro-elements, in progress since 1951, has shown that the potassium content of the leaves was highest where boron was applied and that the boron content of the leaves was the highest in the same treatment.

Nutrition II

Some effects of fertiliser applications on the nutrient composition of leaves and latex of Hevea brasiliensis. V.M. Shorrocks, The Rubber Research Institute of Malaya, Kuala Lumpur

The effects of ammonium sulphate, rock phosphate, muriate of potash, manganese sulphate, copper sulphate and sodium molybdate applications on the nutrient composition of leaves and latex were investigated. The effects of fertilisers were shown more clearly by leaf analysis than by latex analysis.

Rapid effects of nitrogen and potassium fertiliser were observed, whilst the effects of rock phosphate applications were neither rapid nor marked.

Ammonium sulphate increased the nitrogen content and reduced the potassium content. Muriate of potash increased the potassium content and reduced the magnesium content. Rock phosphate increased both the phosphorus and the calcium contents. Manganese sulphate applications increased markedly the manganese content of the leaves and bark, but only slightly the manganese content of the latex. Small increases in the leaf copper content, and marked increases in the leaf molybdenum content, were caused by the application of copper sulphate and sodium molybdate respectively.

The major elements in the foliage of Hevea brasiliensis and their interrelation. J.C. FALLOWS, Dunlop Research Centre, Batang Malaka, Malaya

In Beaufils' system of physiological diagnosis the ratios between the contents of nutrient elements in the leaf are used as a means of diagnosing nutrient deficiencies in *Hevea*. Work was carried out in Malaya to assess the validity of this system under Malayan conditions.

Ratios for N/K, N/P, K/P, K/Mg and Mg/P for 'normal' trees were calculated from analytical results from Malayan leaf material. The 'normal' values obtained for N/K and K/P differ from those given by Beaufils, because of the lower K values found in Viet-Nam.

Results from a manurial experiment were briefly examined with a view to studying the relationships between 'normal' and 'optimum' conditions. 'Normal' conditions occurred with some treatments but 'optimum' conditions did not.

It is consequently thought necessary to determine optimum values for major element ratios in the leaf (i.e. the ratios associated with high-yielding, not merely healthy, trees) before full advantage can be obtained from diagnosis by leaf analysis.

Some studies on carbohydrates of Hevea brasiliensis and on their variations (In French). J. D' AUZAC and S. PUJARNISCLE, Institut des Recherches sur le Caoutchouc au Vietnam

On the contribution of I.R.C.V. laboratories to research on the improvement of the yield of Hevea (In French). P. COMPAGNON, Directeur des Recherches, Instituts des Recherches sur le Caoutchouc au Vietnam et au Cambodge

During recent years, the I.R.C.V. has paid special attention to developing laboratory research capable of contributing to the improvement of yield. Mineral analysis, forming the basis of a system of diagnosis which is used as a guide to correct manuring, is the most outstanding line of research.

When applied to latex, the analysis reveals numerous modifications in a metabolism which is extremely sensitive to interference. It is logical to believe that certain aspects of that metabolism correspond with optimum conditions for high yield.

It is not claimed, in the light of present knowledge, that this metabolism is understood in all its complexity. Nevertheless, it is hoped to define, for certain conditions, features which are indicative of a favourable metabolism, and to correlate the variations in these features with the controllable factors which influence them. The determination of the d.r.c. of latex already gives some useful indications.

Some aspects of mineral composition have been related to the effects of stimulation, and this relationship throws light on the nature of stimulation. It seems possible to relate the responses to stimulation with certain variations in mineral composition. Mineral elements are not the

only factors limiting latex synthesis; organic compounds (accessory precursors and waste products of metabolism) can also provide some indication of latex formation. Research carried out on carbohydrates did not give very positive results but at least showed that these substances probably do not constitute a limiting factor. More recently, determinations have been undertaken on amino-acids and other organic acids.

Investigations in the field of microbiology suggest that it may be worth while to study the possibility that enzymes play a part in influencing yield.

Leaf and latex analysis. P.R. Gyss and Y.B. Menon, Technical Branch, Socfin Co. Ltd, Malaya

A procedure is outlined for analytical work connected with Physiological Diagnosis.

Tapping: Yield Stimulation I

Yield stimulation of Hevea brasiliensis by 2,4-dichlorophenoxyacetic acid. C.A. Puddy and S.M. Warriar, Chemara Research Station, Seremban, Malaya

Practical uses of a yield stimulant of 2,4-D in vegetable oil are described. Aqueous suspensions of inert solids are also effective carriers. Sulphur has no stimulant effect. Copper may cause necrosis and precoagulation.

Panel applications produce a steadier and more persistent stimulation than bark applications, together with a very rapid renewal of bark tappable after three years and giving good yields. On old rubber, 2 in. monthly panel applications have produced a 25% yield increase for three and a half years. The incidence of dry trees is not increased. Yield response to panel applications on young rubber is poor, and the response to bark applications is variable. Growth is checked.

There are significant correlations between yield response and potassium content of leaf and latex. Response may also be associated with leaf calcium and latex magnesium/phosphate ratio.

So far, no effects of differential fertiliser treatments on yield response to stimulants have been obtained.

Intensive tapping of mature rubber. P. de Jonge, The Rubber Research Institute of Malaya, Kuala Lumpur

A survey is given of experiments which have resulted in recommendations for intensive tapping before replanting, see *Planters' Bulletin 15*, page 103 and *32* page 11.

These experiments have shown that well disciplined alternate daily tapping of one high and one low cut (2C/2.d/2.200%) could be maintained successfully for a much longer period than was originally

thought, but only on planting material of low yield capacity, such as unselected seedlings.

Buddings of high yield capacity and clonal seedlings may be tapped on two cuts, but only at intervals of three days, as signs of exhaustion are observed after tapping two cuts alternate daily.

The effect of yield stimulant application has been shown to be disappointing when rubber trees are tapped on a high and a low panel simultaneously.

Great emphasis is placed on the need for high standard of tapping and low bark consumption as the experiments have shown poor yields when a new high panel is opened on virgin bark opposite a previous high panel of which the renewed bark is young or of poor quality.

The effect of introduction of a resting period in connection with double-cut third daily tapping is discussed in the paper.

Discussion

Mr Shearlaw remarked that he disliked Mr de Jonge's suggestion of a single high cut, for economic reasons. There were normally about 450 trees per task on ordinary basal tapping but only 300 on high-cut tapping; that was an increase of 50% in labour. He suggested that a double-cut 100% periodic system (2C/2.d/3.12m/16.100%) be introduced without a period of tapping on a single high cut. On basal tapping, one worker tapped two tasks of 450 trees each; a total of 900 trees. On ladder tapping he would only tap two tasks of 300 trees — a total of 600 — but on the 100% double-cut periodic system, he could tap four tasks (three tapped and one rested) of 180 trees each, making a total of 720 trees. The saving in labour was obvious. The importance of yield per tapper was, he thought, sometimes overlooked. The planter's objective, surely, was maximum profit per acre, which generally speaking did mean maximum yield per acre, but not inevitably so. He suggested that the 100% intensive double-cut periodic system be introduced when the first panel of bark of first renewal had been tapped out after approximately 16 years of tapping. He asked whether Ir de Jonge would comment on that suggestion and also to say if he would be prepared, over the whole of the double-cut tapping period, to use stimulant once in 16 months.

Ir de Jonge replied that the tapping system proposed by Mr Shearlaw sounded very attractive. He added that he had already indicated that the R.R.I.M. might have to revise the idea of first tapping out one high panel before double-cut tapping was introduced. There remained, however, the possibility that clones such as PB 186, RRIM 501 and RRIM 519, might yield higher on alternate daily tapping of a single high cut than when tapped third daily on two cuts. It was difficult to give an opinion on when double-cut tapping should be commenced. He referred to Mr Shearlaw's idea to start double-cut tapping when there was still one panel of bark of first renewal available at low level, whereas the present R.R.I.M. recommendation was to wait until

all bark of first renewal and one high panel had been tapped out. This was impossible to check experimentally in one field as planting material of different ages would be required if the experiment was to yield results in the foreseeable future. The best approach would be to collect a large number of records from estates which could provide material leading to a conclusion on this matter.

With regard to stimulant application, IR DE JONGE pointed out that one application of stimulant during the period of 12 months' tapping would have a good effect on both yield per acre and per tapper and that the method could be followed for as long as the 2C/2.d/3.12m/16 system was carried out. The stimulant should be applied 2-3 months after the resting period.

Yield increases by the treatment of Hevea brasiliensis with antibiotics. D.H. TAYSUM, The Rubber Research Institute of Malaya, Kuala Lumpur

The work described is a development from results obtained with a sterile box surrounding a mature seedling tree tapped on a shortened half-spiral cut. Attention is paid to the duration of flow of latex, its volume, dry rubber content and the degree of viable bacterial contamination.

Observations are extended to seven unselected seedlings injected with a variety of antibiotics and dressed with an alkaline bactericidal detergent. Yield increases are recorded and a brief description of each tree is given, together with the timing of injections. Particular attention is paid to a tree showing symptoms of brown bast.

Twenty unselected seedlings (with twenty control trees) are then treated with 'Vaseline green', an antibiotic-sulphonamide mixture based on neomycin and chloramphenicol. Yield increases are recorded.

An experiment on AVROS 50 buddings at various planting densities is used to compare Vaseline green, Vaseline green + 0.5% 2,4,5-T, three commercial hormone preparations, and 2,4,5-T plus all active components of Vaseline green. Results are discussed.

The comparative success of the Vaseline green preparations in the AVROS 50 experiment is compared with a small response to Vaseline green and a good response to 2,4,5-T in an experiment using Tjir 1 buddings.

A small experiment on clonal seedlings shows a beneficial effect of aqueous bactericidal dressing upon yield, following treatment with Vaseline green and Vaseline green + 0.5% or 0.3% 2,4,5-T.

An experiment on a commercial estate using a fourth-daily, attenuated full-spiral, method of tapping is described. 2,4,5-T, Vaseline green and Vaseline green + 0.5% 2,4,5-T are compared. Yield increases are obtained in all treatments; important differences between treatments are given in full. The experiment is based on eight commercial tapping tasks giving only two replications.

Finally an appraisal of the effects of antibiotics upon yield is made in terms of a concept of immunity.

Uptake and transport of radiocarbon-labelled 2,4-D and 2,4,5-T from tapping panel applications in Hevea. S.E. ALLEN and C.E. RHINES, United States Rubber Company, Plantations Division Research Centre, Wayne, New Jersey, U.S.A.

Chromatography and bio-assay of plant growth substances in Hevea latex. S.G. BOATMAN, The Rubber Research Institute of Malaya, Kuala Lumpur

It has recently been shown that IAA (3-indolylacetic acid), the principal growth substance, or hormone, of many plant tissues, is itself capable of stimulating latex flow. Surprisingly enough, no IAA has been found in *Hevea* latex, but a number of other, unidentified, growth substances are present. It has not been possible, as yet, to show whether, in the absence of artificial stimulation, these unidentified substances play some part in regulating latex flow. When, however, IAA is applied as a yield stimulant, the latex from the treated trees contains, not only large quantities of IAA, but also an increased amount of the natural growth substances. A similar experiment, in which trees were treated with 2,4,5-T, also resulted in an increase in the hormone content of the latex, but stimulation by copper sulphate injection did not, indicating a different stimulatory mechanism by these two substances.

The success of yield stimulant mixtures containing growth substances such as 2,4-D and 2,4,5-T, suggests that, under the C/2.d/2.100% tapping system, low hormone concentration in the bark may often be a limiting factor restricting yields. Work is continuing, with the aim of investigating further the possible effect of these natural hormones on latex yields.

Tapping: Yield Stimulation II

Clonal variations in reaction of Hevea brasiliensis to stimulation of latex yield and of bark regeneration. D.W. LEVANDOWSKY, United States Operations Mission to Viet-Nam

Starting from June 1953, at Firestone Plantations in Liberia, observations are being made on clonal reactions to stimulation of latex yield and of bark regeneration in *Hevea brasiliensis,* using 2,4-D and 2,4,5-T diluted at various strengths in palm oil and petrolatum mixtures. The phenoxy compounds are applied below or above the tapping cut. In bark regeneration studies, the width of areas treated varied from 3 to 24 inches, both above and below the tapping cut.

Eleven clones (BD 5, BD 10, Tjir 1, Tjir 16, AVROS 49, AVROS 50, AVROS 152, PB 180, PB 186, War 4, TK 12) and seedling trees were the subject of the study. The test areas scattered over the plantation (which comprises 85,000 acres of rubber) covered approximately 160 acres and comprised approximately 19,000 trees.

Reactions to stimulation of yield have developed into patterns characteristic of each clone. Some clones showed greater increase in yield than others. The range of rise and fall of the stimulated yield increase also differed in various clones. Some clones showed a below-control yield at the end of the 6-months period between treatments. Other clones, for example BD 10, have shown little or no below-control yield during several years of stimulation. There seemed to be differences in clonal reaction to the two phenoxy compounds.

The tapping system (23 days consecutive tapping and 23 days rest, or alternate daily tapping) also produced differences in clonal reaction to stimulation.

In bark regeneration, the rate of formation of new bark, (both sound and abnormally proliferated) also varied with clones.

Ecology, Environment: Ground Covers, Weed Control I

The possibilities for pre-emergence weedkillers in immature rubber. G. WRIGLEY, M.A. FLETCHER, R.K. PFEIFFER, E.D. CHILWELL, Chesterford Park Research Station, Fisons Pest Control Ltd, near Saffron Walden, England

Observations of planting methods on rubber estates indicated two possible fields where the pre-emergence technique could be used: (1) to maintain weed-free planting rows in immature rubber during the initial stages in the life of the tree; (2) to prevent weed growth in cover crops during the first year after planting.

Evidence was required to determine: (a) the effective persistence of herbicides under the range of soil and climatic conditions found on rubber estates; (b) their effectiveness against the weed species commonly encountered; (c) their toxicity to various crops.

In order to establish the required data, an extensive programme of field trials with simazine has been carried out in Malaya, in conjunction with laboratory investigations at the Chesterford Park Research Station. The results of this work can be summarised as follows:

1. Simazine was effective against the seed of all the important grass and broad-leafed weeds encountered in the trial sites including *Paspalum conjugatum*.
2. In general, the length of the period in which weeds were successfully controlled with simazine increased with increasing dosage rate, but the relationship was not linear, i.e. 10 lb simazine did not give double the period of control given by 5 lb.
3. Once weed control with simazine broke down, recolonisation, particularly with *Axonopus compressus* and *Paspalum conjugatum*, was rapid. *Imperata cylindrica* (*lalang*) did not invade any

plots and *Panicum maximum* occurred only once.

4. The control achieved by 5 and 10 lb per acre was of insufficient duration to compete with hand weeding at present costs.
5. At 15 lb per acre, weed control was achieved for 5-6 months at the majority of sites. This period was shorter than anticipated from our experience in other countries.
6. The leguminous cover crops planted between the rows of young rubber spread by runners and can take root in soil treated with simazine. The established legumes appeared to be resistant to all dosage rates.
7. The higher rates of simazine appeared to delay the spread of creeping grasses from the cover crops into the planting rows.
8. Effect on *Hevea*. From the trials it appears advisable to avoid spraying basket seedlings and newly planted seedlings until they have been at least four months in the ground, and to keep the spray at least six inches away from the seedlings. At a dosage of 15 lb per acre, the risk to new plantings appears small, and negligible on the older seedlings. Established young plants appear not to be damaged even when grossly overdosed.

Some aspects of the growth of Hevea buddings. J.K. Templeton, The Rubber Research Institute of Malaya, Kuala Lumpur

The effect of stock size at budding on subsequent scion growth was studied for two clones (RRIM 501 and RRIM 513) during their first 21 months after budding. The stocks were all of the same age but varied widely in girth (2 to 12 in. at 12 in. above ground level).

It was found that the buddings on the larger stocks grew in height more rapidly and reached a greater total height than those on smaller stocks. Height at which the canopy developed was, on average, a little greater for those trees on the larger stocks.

At the end of about 9 months, trees on larger stocks had more girth and dry weight but thereafter, although differences between the stock groups widened, the relative rates of increase were similar.

Also for a period of about 9 months, buddings of RRIM 501 were distinctly more vigorous than those of RRIM 513. During the second year, however, rates of growth in girth and dry weight differed little between clones.

Psophocarpus palustris; an ideal ground cover for oil palm and rubber. Tan Hong Tong, Jap Kim Tjong and Ismail Parlindungan Lubis, Research Institute of the Sumatra Planters' Association (formerly A.V.R.O.S.) Medan, Indonesia

Psophocarpus palustris is a ground cover which became very popular in East Sumatra after the war. The plant is indigenous to tropical Africa. It is a perennial legume which lasts well under favourable circumstances and does not become woody. Although it will grow well everywhere and is rather resistant to shade, it flourishes best on marshy

and low-lying white-clay soils, especially where exposed to full sunlight. After planting, its growth is somewhat slow at first, but once well established its growth is very vigorous; in this respect it surpasses all known ground covers. The flowering and seed-bearing properties are quite good and it roots quite deeply. *P. palustris* is fairly resistant to pests and diseases.

The germinative power of its seeds deteriorates quickly under normal conditions (from 90% to 25% within one month), but if the seeds are stored in a spacious building, where they can be smoked regularly, they will retain their germinative power for a long period.

Ecology, Environment: Ground Covers, Weed Control II

Vegetation sampling in cover plant trials. M.M. CHANDAPILLA, The Rubber Research Institute of Malaya, Kuala Lumpur

Vegetation has been sampled in cover plant trials by a combination of regularly arranged milliacre quadrats and random points within the quadrats. The contributions made by the different components of the vegetation are judged by their cover estimates. The cover estimate is determined from the number of points at which each species is present.

The natural cover regeneration plots in trials on four sites with different histories are compared. The species assemblage is richest in a new planting and poorest in a replanting from rubber previously abandoned to *Gleichenia* thicket. The coverage is worst on a hill site. *Trema orientalis* is associated with recent burning whereas *Ficus alba* is more common in unburnt areas. The majority of the main natural constituents of the vegetation have seeds dispersed by animals (especially bats and birds).

The method promises to be very useful in determining differences in vegetation on various soils and under different methods of management. A series of samplings will allow changes with time to be studied as the trees mature.

Comparative studies of the chemical composition of some cover plants. A.J. JEEVARATNAM, The Rubber Research Institute of Ceylon

Cover plants and mulching materials vary in their ability to improve the fertility of the soil, depending on the nature and amount of dry matter produced and on the chemical composition of the different plants.

Results of comparative studies of the amount of dry matter produced and the chemical composition of three leguminous cover crops, *Pueraria phaseoloides, Centrosema pubescens* and *Desmodium ovalifolium,* and two non-leguminous cover plants, *Mikania scandens* and *Tripsacum laxum* (Guatemala grass) are reported. Guatemala grass was found to

have the lowest content of N, P, Ca and Mg, but had the greatest total amount of plant nutrients N, P and K, by virtue of the relatively large quantities of dry matter which it produced.

Two of the leguminous cover plants investigated, *Pueraria phaseoloides* and *Centrosema pubescens*, returned larger amounts of nitrogen than did *Mikania scandens*. The third leguminous cover plant, *Desmodium ovalifolium*, was in fact poorer in chemical composition than *Mikania*. The non-leguminous cover plants contained large quantities of K but were low in Ca and Mg.

These results indicate that the chemical composition of cover plants and mulching materials can exert considerable influence on the nutrition of *Hevea*.

Cover plants and the soil nutrient cycle in Hevea cultivation. G.A. WATSON, The Rubber Research Institute of Malaya, Kuala Lumpur

This paper presents a progress report on four experiments that compare the effects of covers of leguminous creepers, grasses, *Mikania scandens* and 'natural' covers on growth of the rubber tree. Covers of leguminous creepers have been found to mobilise larger quantities of nitrogen, phosphorus and calcium than do the other covers; trees grown in association with leguminous creepers have been found to contain enhanced levels of nitrogen and phosphorus in their leaves. In two of the four experiments, higher rates of growth have been found in trees grown together with leguminous creeping covers than in trees of the other cover plant treatments.

The total nutrient content of a stand of five-year-old trees, at 150 trees per acre, has been estimated; the data show that at two years from planting the covers of leguminous creepers and 'natural' covers have already mobilised a major proportion of the nutrients that will eventually be required by the trees.

A cover of *Mikania scandens* does not mobilise as large a quantity of nutrients as does a leguminous creeping cover, and in three of the four experiments the *Mikania* appears to have checked tree growth.

Effects of ground cover type and continuity of nitrogenous fertiliser treatment upon the growth to tappable maturity of Hevea brasiliensis. B.J. MAINSTONE, Dunlop Research Centre, Batang Malaka, Malaya

This experiment on the development of replanted *Hevea brasiliensis* compares the effects of: firstly, a sown and maintained leguminous cover with a naturally regenerated non-leguminous cover principally made up of grasses and *Mikania scandens* (natural cover); secondly, ammonium sulphate fertiliser applications, as normally given to trees throughout immaturity, with ammonium sulphate applied only up to eighteen months after budding.

The experiment is sited on a Malacca series sandy clay loam where the old rubber stand had been poisoned. The clone used was PB 86.

The type of ground cover used had a greater effect upon tree growth

than the level of ammonium sulphate. Nitrogen level had no significant effect upon the time of attaining tappable maturity when trees were grown in association with a leguminous cover. Stands of trees in leguminous cover plots were tappable 12 months earlier than those grown in natural cover plots. In these latter plots, treatment with the higher level of ammonium sulphate hastened tappable maturity by 7 months.

These effects, based on tree girth measurements, achieved a high level of significance. Investigation of other aspects, including canopy density and nitrogen content of tree leaves, also showed significant treatment effects which are considered complementary to those for girth.

The results of the experiment indicate that once a budded stand of *Hevea brasiliensis* has been established, the quality of cover is more important than nitrogenous fertiliser application.

Breeding and Selection: Vegetative Propagation I

The performance of RRIC clones under Ceylon conditions. C.A. DE SILVA, The Rubber Research Institute of Ceylon

Early attempts made in 1935 to establish new clones from high yielding imported clonal seedlings have provided three promising RRIC clones selected from a second and larger scale clone trial initiated in 1945.

In 1938, new clones were established from selected Tjikadoe seedlings imported from Indonesia. Improved methods of selection have resulted in the recommendation to the industry of the three high yielding Nab clones — 12, 15 and 20.

From 1939 to 1945 a systematic breeding programme was carried out with the available high yielding local and foreign clones. The selection of clone parents was based primarily on high yield and on seed setting qualities, together with satisfactory morphological characteristics.

From a total of about 3000 clones, established from hand-pollinated seedlings planted from 1941 to 1947, the performance of a number of selected high yielding 'RRIC' clones is presented and discussed, with special reference to susceptibility to diseases caused by *Phytophthora palmivora*, a pathogen which threatens to become an appreciable factor in the economics of rubber production in Ceylon.

The decision taken in 1949 — only two years after the RLD (now RRIC) series was established — to test selected new clones with 150 trees of each, has given us clones RRIC 86 and 87 which, at the present time, are yielding up to the standard of the control clones PB 86, RRIM 501 and 513.

The difficulties of making recommendations to the industry on new

clones before they have been sufficiently tested in experimental plantings are briefly discussed.

Observations on the 1959 hand pollination programme at the Rubber Research Institute of Malaya. J.M. Ross, The Rubber Research Institute of Malaya, Kuala Lumpur

A heavy drop of immature fruit resulting from the 1959 hand pollination programme was observed approximately mid-way between the dates of pollination and harvest.

No differences were found between the crosses made in terms of number of fruit harvested, although significant differences were found in terms of developing fruit.

Inexperienced pollinators made fewer pollinations, per inflorescence and per day, than experienced pollinators and achieved a higher percentage of success. The experienced pollinators obtained more harvested fruit per day's pollination work.

The family RRIM 501 selfed is shown to be as successful as the outcrosses in the programme.

Some possibilities of improving the success of hand pollinations in terms of fruit harvested per day's pollination work are discussed.

Vegetative propagation of clones of Hevea brasiliensis by cuttings. G.H. Tinley, The Rubber Research Institute of Malaya, Kuala Lumpur

A technique is described for rooting leafy cuttings of clones of *Hevea brasiliensis* and hybrids between *H. brasiliensis* and *H. benthamiana*, using mist propagation. The root forming ability of a number of clones is recorded and the successful rooting of two important clones, PB 86 and GT 1, is shown. Rooted clones will be valuable uniform material for experimental work and stock-scion effects can be examined accurately. The early growth of cuttings planted into a nursery is illustrated and promises that this method may have advantages over budgrafting if present establishment problems can be overcome and a wider range of clones satisfactorily rooted.

Green-bud strip budding of two- to eight-month-old rubber seedlings. H.R. Hurov, Department of Agriculture, North Borneo

A method of budgrafting 2- to 8-month-old rubber seedlings with green budwood is described. Successes of between 65 and 95% have been recorded on approximately 100,000 rubber seedlings budgrafted during the first half of 1960 in North Borneo. Suitable seedlings for budding may vary from $\frac{1}{4}$ to 1 inch in basal diameter and the bases of these seedlings may either have green or brown bark. For green bark seedlings, however, heavy phosphatic manuring is required prior to budgrafting.

The most desirable budslips for budding are the dormant buds obtained from green terminal flushes which have just reached the non-drooping, pinkish green leaf stage.

Budwood may range in size from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter and from

12 to 15 inches in length.

Budwood has been successfully stored 3 days and shipped 150 miles by road and rail.

Polythene tapes, with medicinal adhesive appendages at both ends, are used for binding the budpatches to the seedlings.

Breeding and Selection: Vegetative Propagation II

Breeding for high yield and disease resistance in Hevea. E.D.C. Baptiste, Director, The Rubber Research Institute of Ceylon

The selection and breeding of *Dothidella*-resistant *Hevea* clones in Brazil is reviewed in some detail. A complete list is presented of these clones imported into Ceylon for breeding work aimed at combining resistance with the high yield of Eastern clones, using the backcross method of breeding.

An appraisal is made of the clones on their reaction to *Dothidella ulei* and to *Phytophthora.*

Examples are given of apparent breakdown of disease resistance and the importance is stressed of the need for diversification of highly resistant material for use as genotypes.

Since tests of *Dothidella* resistance can be carried out only in the Western hemisphere, where the fungus is present, the location of a testing station is discussed and Turrialba in Costa Rica is considered to be the best centre for the purpose.

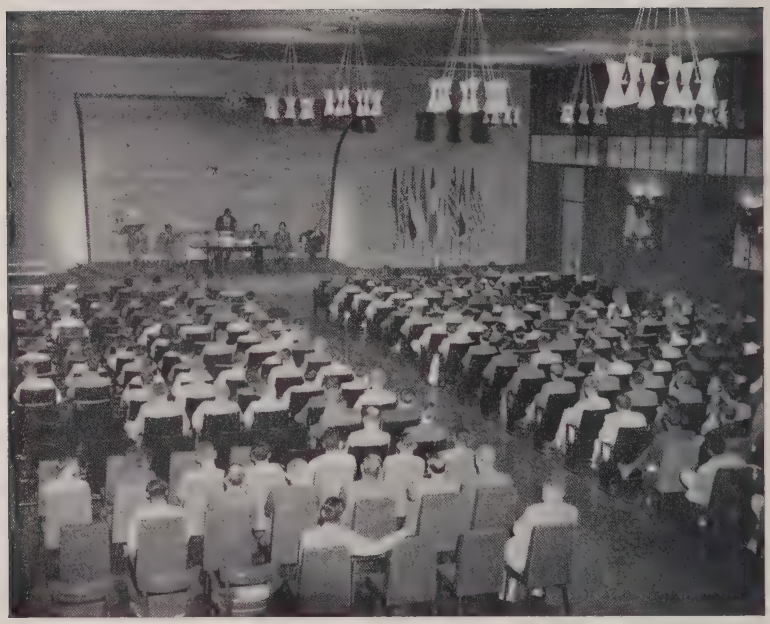
It is suggested that all natural rubber producing countries should take joint action to have the project implemented by an international body such as the Food and Agriculture Organization of the United Nations.

Dothidella ulei and the selection and breeding of Hevea. Th. G.E. Hoedt, Pirelli Plantation, 'Oriboca', Belém, Pará, Brazil

Observations and experience with reference to the most harmful disease of *Hevea,* caused by the fungus *Dothidella ulei* (popularly known as South American Leaf Blight) are discussed.

The disease has spread from the Amazon valley to all adjacent rubber-growing countries of the Western hemisphere, and recently made its appearance in the coastal rubber district of the state of Sao Paulo, Brazil, a thousand miles south of the rubber district of Bahia, where *Dothidella* has been present for a long time. The use of records of relative humidity to forecast the time, place and intensity of attacks of *Dothidella* is explained.

Methods of control of *Dothidella* are discussed; direct methods by spraying with fungicides, and indirect methods by the use of resistant planting material. The results of selection and breeding of high yielding resistant clones are given.



The Hon'ble Inche Mohamed Khir Johari, Minister of Commerce and Industry, Federation of Malaya, opening the Natural Rubber Research Conference at the Tunku Abdul Rahman Hall.

Research Divisions of the R.R.I.M. held exhibitions of their work for the benefit of the delegates. This group is inspecting bacteria isolated from latex in the Chemical Division.

Delegates inspecting latex rail tanks at a port installation.

A field trip. Delegates inspect a cover plant experiment at the Experiment Station.

Pests and Diseases I

Experiments on the control of abnormal leaf fall of Hevea caused by Phytophthora palmivora in South India. T.S. RAMAKRISHNAN, Rubber Board, Kottayam, Kerala State, India

Abnormal leaf fall is the most serious disease of rubber in South India, occurring every year in the months of May to August; it is responsible for a considerable reduction in the yield of latex and shortens the economic life of the trees. The pods are the first to be infected but their removal does not always reduce infection.

Protection of the trees is essential. Spraying the foliage with 1% Bordeaux mixture, before the monsoon rains set in, is the most effective method of control.

Difficulties are experienced in using Bordeaux mixture. Dust formulations of copper fungicides are of little value under local conditions. Oil-based copper oxychloride and colloidal copper formulations applied through a Micron sprayer have given encouraging results in budded areas in more than one estate. A few trees which showed resistance in the field are under further study.

Pests and Diseases II

Recent progress in the control of the white root disease of Hevea. A. RIGGENBACH, The Rubber Research Institute of Ceylon

The method of control of the white root disease of the rubber tree (caused by the fungus *Fomes lignosus*), consisting of the surface application to infected roots of a copper sulphate solution after scraping off the fungus mycelium, gave disappointing results. Consequently laboratory tests and field experiments with a wide range of fungicides were carried out at the Rubber Research Institute of Ceylon.

As a result of these experiments and of the successful use in commercial areas replanted with rubber, Tillex, an organo-mercurial fungicide, is now recommended by the Institute, instead of copper sulphate, for the control of the white root disease of *Hevea*.

White root disease of Hevea brasiliensis: the identity of the pathogen. R.A. FOX, The Rubber Research Institute of Malaya, Kuala Lumpur

The history of the nomenclature of the white root disease fungus is briefly reviewed. Its fructifications have often been confused, both in the field and in herbaria, with those of several other species of fungi, in particular with those of the *Polyporus rugulosus-zonalis* complex. This confusion makes it necessary to re-examine the validity of the use of the name *Fomes lignosus* for the pathogen. Some implications of the confusion between the parasite and species of the saprophytic '*zonalis*' complex are discussed.

Factors affecting root disease incidence and control in replanting. F.W. HUTCHISON, The Rubber Research Institute of Malaya, Kuala Lumpur

The methods of controlling root disease of *Hevea* have changed radically in Malaya since the war. The stimulus came largely from the need to economise on labour, as wages rose. However, field experiments on root disease are of such long duration that it was not until 1955 that a start was made on revising the published advice issued by the Rubber Research Institute of Malaya. In 1958 there was sufficient experimental evidence to issue radically revised recommendations for cheaper and more effective control measures.

This paper presents data from those field experiments, laid down from 1948 onwards, on which the new concepts of control are based. It also reviews some of the findings of pre-war experiments in the light of later results.

The main factors influencing the incidence of root disease in a replanting are considered. Tree or stump poisoning of the old stand at the time of clearing materially reduces the incidence of disease, even in the absence of preplanting eradication of diseased trees. Spore colonisation of moribund stumps has been shown to play an important part in disseminating disease; it is largely preventable by protective treatment of the cut surfaces of stumps at the time of felling. The costly method of detecting disease in a young stand by periodic tree-to-tree collar inspection is no more effective in saving trees than the far simpler foliage inspection. Avoiding unnecessary disturbance of the soil has been shown to result in fewer losses, while isolating sources of infection has been found as effective as eradicating them.

Sporulation of Fomes lignosus, Fomes noxius, and Ganoderma pseudoferreum. R.N. HILTON, The Rubber Research Institute of Malaya, Kuala Lumpur

The paper describes laboratory and field experiments and observations bearing on spore liberation from the fructifications of the three major root disease fungi occurring in Malaya. The few days to form, followed by hours to spore, necessary for the *F. lignosus* fructification is contrasted with the months to form followed by weeks to spore of the *F. noxius* and *G. pseudoferreum* fructification. However, once sporing commences, all three species spore abundantly and their spores can be trapped in the air of a plantation. It remains to be demonstrated how much of a threat to the plantation this potential inoculum constitutes.

Decay of rubber wood. A. NEWSAM, K.P. JOHN and B. SRIPATHI RAO, The Rubber Research Institute of Malaya, Kuala Lumpur

Quick decay of the remains of the old stand is of considerable importance in reducing the incidence of root disease in a replanting. A preliminary study of the process of decay of poisoned rubber, and the agents responsible for it, is reported.

Observations have been made on the fungi and insects that derive their sustenance directly or indirectly from dead and decaying rubber, converting it to humus. Their numbers, as well as the rate of decay, are greater where a ground cover is established. An indication of the rate at which the surface timber can be converted to humus is given.

Excavation of the boles of trees and stumps a year after poisoning with sodium arsenite or 2,4,5-T showed that there had been considerable decay, which was more advanced following 2,4,5-T poisoning.

An experiment is reported comparing tree poisoning with stump poisoning, 2,4,5-T with sodium arsenite, insecticidal treatment of the poisoned stumps or trees with no such treatment, and their inoculation with *Fomes lignosus* with no inoculation. The superiority of 2,4,5-T is confirmed, and it is shown that, in so far as the above-ground parts are concerned, stump poisoning resulted in quicker decay and treatment with insecticides slowed the process in the stumps. Inoculation with *F. lignosus* had no effect.

PREPARATION AND USE OF NATURAL RUBBER AND LATEX

Chemistry and Technology of Dry Rubber I

Inhibition of hardening in natural rubbers. B.C. SEKHAR, The Rubber Research Institute of Malaya, Kuala Lumpur

The hardening of natural rubber in the form of sheets or crepes during storage was ascribed by the author in an earlier paper to the presence of a number of aldehydic groups in the rubber molecule. In the present paper, the author provides further support for this hypothesis by showing the effect of diamines and formaldehyde treatments.

The paper indicates the magnitude of variations in aldehyde group contents and plasticity variations in clonal rubbers. Simple methods for estimating the aldehyde group contents, and for inhibiting the reaction of these groups which leads to hardening, are described.

With the information presented in this paper, it is now possible to produce rubbers which do not change in their plasticity values on storage. In other words, a more standard form of natural rubber can now be produced.

Processing and processability of polyisoprene and natural rubber. R.H. SNYDER, P.M. NICHOLS, D.E. FREIWALD and H.W. HOERAUF, United States Rubber Company, Product Development, Tire Division

Cis-polyisoprene first became commercially available in early 1959. Very large volumes of the polymer have been processed over the past 18 months and a realistic appraisal of the over-all qualities of this commercial elastomer is now possible.

Although similar to natural rubber in many respects, cis-polyisoprene differs markedly from natural rubber in certain raw properties. Major differences are:

(a) Tendency to 'looseness' or 'bagginess' on mill rolls under temperature conditions where natural rubber forms a tight band.
(b) Tendency to crumbling on mills, in Banbury Mixers, or in the Mooney Viscometer at elevated temperatures.
(c) Tendency to a characteristic surface scaliness when extruded.
(d) Markedly different flow properties.

Cis-polyisoprene is more like natural rubber than emulsion type polyisoprene or SBR in respect to tack; however, there is a greater tendency for joined raw surfaces to separate under a small continuous load than with natural rubber stocks.

In most cases the practical difficulties of handling polyisoprene can be overcome by suitable changes in equipment, techniques, or compounds. The unique flow characteristics are a distinct advantage in many applications and in most cases preplastication can be eliminated.

The raw properties of cis-polyisoprene have been examined in considerable detail in the laboratory using the Mooney Viscometer and the Instron Stress-Strain Tester. Data over a wide temperature range are presented which provide a plausible explanation for many of the

processing qualities of cis-polyisoprene. The laboratory tests employed should have general utility in the characterisation of other polymers in respect to their processing qualities.

Preparation and application of natural rubber-acrylamide block polymer. SHINTARO KUNISAWA* and YUJI MINOURA**, *Foundation for Natural Rubber Research and Development, Tokyo, Japan; **Department of Chemistry, Research Institute for Atomic Energy, Osaka City University

Natural rubber acrylamide block copolymer was obtained by heating a mixture of natural rubber and acrylamide mixed on a cold open mill. Studies were made of the effect of the mixing and heating conditions on the polymerisation reaction. The copolymer obtained showed good oil resistance and excellent abrasion resistance. Coloured tyres were manufactured from this copolymer on an experimental scale and one of these tyres was tested.

Reactions of rubber hydrocarbon with some olefine monomers (In French). C. PINAZZI, J.C. DANJARD and R. PAUTRAT, Institut Francais du Caoutchouc

Methyl methacrylate rubber grafts of predetermined molecular characteristics. B.C. SEKHAR, The Rubber Research Institute of Malaya, Kuala Lumpur

The effect of monomer and initiator concentrations on the side chain lengths of methyl methacrylate-rubber grafts has been investigated. It is shown that the effect of initiator concentration on side chain length is significant only for monomer concentrations above 25%. Based on these results, a method has been developed to control the molecular weight of side chains effectively. The method is described and technological applications are discussed.

Chemistry and Technology of Dry Rubber II

New types of superior processing rubbers. B.C. SEKHAR and P.S. NIELSEN, The Rubber Research Institute of Malaya, Kuala Lumpur

An investigation was made into the effects of small additions of selected polymeric materials on the processing properties of rubber. The physical properties of filled and unfilled compounds containing such materials and the effect of method of addition were investigated. It is shown that rubbers containing these materials are superior to normal rubbers in respect of processing characteristics and that the best physical properties are obtained if the polymeric material is added to latex before coagulation.

Manufacturing advantages obtained by the use of SP rubber. H.C. Baker and S.C. Stokes, Natural Rubber Producers' Research Association, Welwyn, England

The main applications of SP rubber have been in extrusion processes where its use permits greater latitude in the range of operating conditions and gives greater scope for compounding for improved physical properties. Compounds based on SP rubber extrude smoothly at lower temperatures, higher viscosities, and higher screw speeds. An associated feature of major importance is the increased extrusion throughput thus possible. This greater productivity is additionally valuable with compounds prone to 'scorch', since higher extrusion speeds can be maintained at lower temperatures. SP rubber compounds also show improved shape retention and dimensional stability and, during pan curing, reduced collapse and less watermarking. Further, for high quality articles, compounds may be upgraded in physical qualities and still retain good processing properties. With calendered goods, easier stripping from the liner cloth, better surface finish, and reduced shrinkage during the cure of hand-built articles are some of the reported advantages resulting from the use of SP rubbers.

The development of PA 80, which confers SP properties to any grade of rubber which the manufacturer wishes to use, has greatly extended the usefulness and enlarged the potential outlets for SP rubbers. PA 80 can be blended with other rubber on open mills and internal mixers, and when added to RSS in the ratio 1 : 3 gives a blend which behaves similarly to SP RSS. The proportion of PA 80 can be increased if required to give still better processing properties and for particularly difficult extruded sections it can constitute as much as 50% of the total rubber content with only a slight reduction in the final physical properties. A comparison of extrusion compounds containing other processing aids shows PA 80 to general advantage.

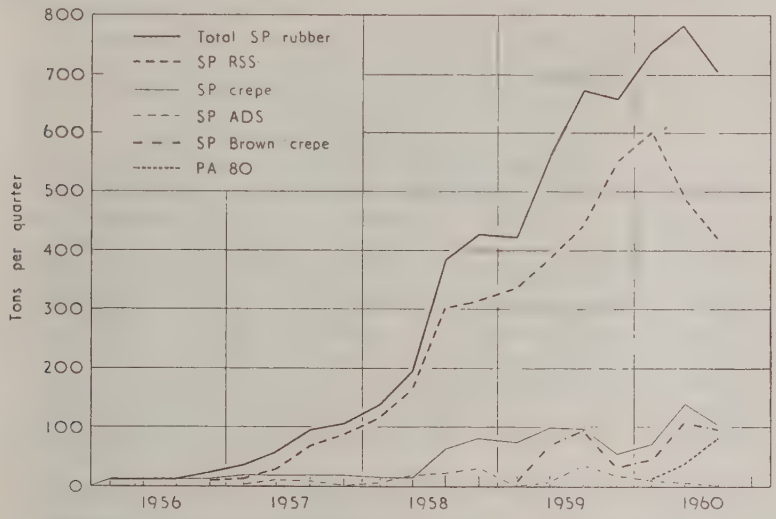
New investigations on the size, form and mobility of the rubber molecule. G.V. Schulz and A. Mula, Institut für Physikalische Chemie der Universität Mainz

Production of SP rubber. G.W. Drake, The Rubber Research Institute of Malaya, Kuala Lumpur

The history of the development of SP rubbers is sketched and the final methods established for commercial production of each type are described. Some of the technical difficulties encountered are mentioned and the manner in which they were overcome. The methods of chemical and physical tests and specification limits used to ensure that no defective SP rubber is sold are described.

Some account is given of the way in which SP rubber was brought to the attention of rubber users at a reasonable price and the role of the R.R.I.M during the early stages of commercial development is explained.

Diagrams are presented giving details of SP rubber produced since production began, the number of estates producing it and the destination of SP rubber shipments.



*Quarterly shipments of SP rubbers.**

Electron microscope research on natural rubber by special methods. FRITZ GRASENICK, Balai Penjelidikan dan Pemakaian Karet Bogor, Indonesia and Forschungsstelle für Elektronenmikroskopie an der Technischen Hochschule Graz, Graz, Austria

Properties of low grade rubber (estate brown crepe). J.E. MORRIS and P.S. NIELSEN, The Rubber Research Institute of Malaya, Kuala Lumpur

Until recent years little knowledge has been generally available of the technical as opposed to visual properties of all the various commercial grades of natural rubber. Most evaluation work has been carried out on No. 1 Pale Crepe and No. 1 RSS, on which considerable data are available. A programme of work was commenced in 1959, and is still continuing, to collect samples of all commercial grades of natural rubber and to evaluate the raw rubber and compounded rubber properties.

This paper gives details of the raw rubber properties of samples of estate brown crepe collected from a number of estates in Malaya.

Results of tests on the raw rubbers and pure gum compounds (ACS-1) prepared from these rubbers are given. The relationship of properties to commercial grade has been examined.

* Graph extended for *Planters' Bulletin*

The mechanico-chemical synthesis of superior processing rubbers. R.J. Ceresa and R.A. Wynn, National College of Rubber Technology, London

Chemistry and Technology of Latex I

Changes in latex structure in ammonia preserved field latex on degradation. C.S. Krishnaswamy, Guthrie Latex Limited, Malaya

A method is described making it possible to observe the changes which take place when ammoniated field latex, as received in a latex centrifuging plant, undergoes degradation. A study of latices from different sources shows that the changes commence at a specific point in the course of degradation. A colour reaction based on the enzymic reduction of picric acid and adsorption of the coloured material on the proteins has been established, enabling the point at which changes commence to be observed with the naked eye.

Results of chemical analyses of the substances undergoing the complex changes are given. A theory explaining the reaction and its significance to the structure and stability of latex is put forward and supported by experimental evidence.

Factors that activate or inhibit the process are studied and classified. A procedure is given which facilitates separation of the substances in sufficient quantity to enable chemical analyses to be performed and thus the variation amongst latices from different sources both before and/or after degradation to be assessed. Results of typical analyses are given and discussed.

The application of the principles involved to quality control work in centrifuge processing plant is given.

The specific gravity of natural rubber latex. S.N. Angove and G.W. Drake, The Rubber Research Institute of Malaya, Kuala Lumpur

The most important factors affecting the specific gravity of natural rubber latex are dry rubber content (d.r.c.) and temperature. The effect of changes in d.r.c. upon specific gravity have been well established but there is a lack of information on the effect of temperature.

The specific gravity of latex concentrates from the same source of field latex over the d.r.c. range 59.45 to 61.07% has been measured at temperatures from 4 to 35°C. An exact relationship between specific gravity and d.r.c. could not be established at each temperature.

Specific gravity determinations of commercial concentrate latices over the same temperature range established a linear relationship between specific gravity and temperature at d.r.c. 60.10%, which is close to the average of a large number of commercial latices.

In order to obtain the weight of a bulk of latex, tables are given to correct the volume of latex at any temperature from 0 — 35°C to the volume at a standard temperature.

Latex is at present sold under R.T.A. (London) C.I.F. Contract No. 10 which allows for the effect of variations of d.r.c. upon specific gravity. The present paper implies that the effect of temperature must also be considered.

For example on a shipment of 50,000 gallons the effect of a difference of 0.2% d.r.c. upon the specific gravity amounts to 72 lb of dry rubber. The effect of ignoring a temperature difference of 15°C between tropical and temperate climates is 2,500 lb.

Further work on this subject is being undertaken.

Zinc stability time and latex processability. J.L.M. Newnham, K.O. Calvert and D.J. Simcox, The Dunlop Research Centre, Birmingham, England

The zinc stability time or Z.S.T. test gives a general indication of the suitability of a latex for a given process. The test is a new approach to the measurement of the stability of latex in the presence of zinc oxide, which embodies modifications and refinements of previous methods. It is based on the attainment of a chemical equilibrium under carefully controlled conditions and characterisation by a mechanical stability measurement. The reproducibility of the method has been shown to be good by inter-laboratory testing.

Although the test was originally developed with natural latex after arrival in Great Britain, the method is also useful for characterising fresh concentrate. The test is also valuable in the investigation of blends of natural latex with butadiene/styrene 'cold' latex.

The method provides a valuable measure of sensitivity to zinc oxide, which is of use for process adjustment or for control checking of consecutive latex batches. The values provided by the test are shown to correlate well with performance in processing. For blends of natural latex with butadiene/styrene 'cold' latex, the test shows how the processability of the natural will be affected by the proportion of the synthetic latex. These conclusions are supported by practical experience, mainly in making foam rubber.

The preservation of natural field latex. J.S. Lowe, Dunlop Research Centre, Batang Malaka, Malaya

Controlled experiments involving both counts of viable bacteria and the formation of V.F.A. due to the bacteria, have shown that adequate preservation of field latex with ammonia is very difficult to obtain. Cup ammoniation wasted more than half the supplied ammonia. In areas yielding more than six gallons of latex per tapper it has been found that, because of the unreliability of the human element, the quality of the latex as judged by the subsequent V.F.A. formation was improved by discontinuing all forms of field ammoniation.

Formaldehyde, the only other bactericide in the same price range as ammonia, was found not to be usable in certain areas where the magnesium content of the latex was high, nor could it be used with safety after rain in many of the clonal latices.

Chemistry and Technology of Latex II

Observations on the properties of skin rubbers. W.L. RESING. Institut des Recherches sur le Caoutchouc au Cambodge

Serum obtained by centrifugation was coagulated in several ways: by bacterial decomposition, and by the use of formic and sulphuric acid, calcium chloride and alum, with or without partial evaporation or neutralisation of ammonia. Data are given for the weight of skim crepe obtained as compared with the d.r.c.

Scorch, tensile properties and behaviour on the Goodrich flexometer of the rubbers were determined in MPC mixes with 0.8% santocure and 0.6% MBT acceleration.

The most important findings are the good overall properties of skim rubbers obtained by fermentation until spontaneous coagulation occurs and the bad influence of calcium chloride coagulation on tensile strength and fatigue resistance under dynamic compression.

Application of radiation in the technology of natural rubber latex. T.C. GREGSON, T.H. ROGERS, L.B. BANGS and D.W. PEABODY, The Goodyear Tire and Rubber Company, Research Division, Akron, Ohio, U.S.A.

A study was undertaken of the effects of high energy radiation on natural rubber latex. Cobalt-60 gamma rays were used at doses of from one to twenty megarads.

Irradiation improved storage properties particularly with de-ammoniated latex. As the dose increased, the latex darkened.

Foam rubber from irradiated latex exhibited improved compression and shock efficiency. Tensile strength and elongation were slightly decreased and volume shrinkage of moulded foam stock was increased. The threshold dose was about one megarad.

Several additives improved the compression of foam rubber when added prior to irradiation.

Extrusion flow properties of rubber from irradiated latex approached those of 'superior processing' rubber.

Irradiation of latex provides a practical method of improving properties for several commercial applications.

Natural rubber latex irradiation treatments could be accomplished on a commercial scale with currently available radiation generating sources, either electron accelerating machines or radioactive isotopes. Preliminary cost estimates on latex foam applications indicate that a 1 Mr dose is more attractive from an economic stand point than is a higher dose.

Although the results are based on preserved, concentrated latex it is reasonable to assume that comparable data would be obtained using fresh natural latex. This would permit irradiation at the plantation site and would allow different products (concentrated latex, improved extruding rubber, etc.) to be made at the same site.

Clonal influence on latex foam properties. P.R. Gyss, C.E.C. Woo and Chan Shee Peng, Technical Branch, Socfin Co. Ltd., Malaya

Latex from monoclonal areas of Tjir 16, PB 186, RRIM 501, PR 107, Gl 1 and GT 1 was collected at various times of the year and concentrated in a laboratory centrifuge.

The concentrates were preserved with ammonia and studies were made, with and without admixture of a proportion of synthetic latex, on their foaming behaviour and the properties of the vulcanised foams.

Differences due to clonal origin and to season were observed. Synthetic latex admixture has considerable effect and the behaviour of the mixtures does not parallel that of the clonal latices.

Developments in the use of latex in association with fibres. S.C. Stokes and E.G. Pole, Natural Rubber Producers' Research Association, Welwyn, England

The use of latex in the carpet, non-woven fabric, upholstery and allied industries is reviewed, processing techniques are described and suitable natural rubber latex compounds are detailed.

Improved equipment for determination of KOH number in latex. P.R. Gyss, Technical Branch, Socfin Co. Ltd., Malaya

A simple electronic circuit and its associated mechanical equipment are described for the automatic addition of fixed-volume increments in potentiometric titrations such as KOH number determination in concentrated latex. It is cheap and can be readily built from locally available components.

Studies on gamma-irradiation of natural rubber latex. M. Asao* and Y. Minoura**, *Foundation for Natural Rubber Research and Development, Tokyo, Japan; **Department of Chemistry, Research Institute for Atomic Energy, Osaka City University, Osaka, Japan

Natural rubber latex was vulcanised by gamma-irradiation. Water accelerates the reaction, but no appreciable difference in cross-linking rate was found between latices of various concentration. The properties of the latex are not adversely affected. The maximum tensile strength of the dried film is greater than that of solid rubber irradiated in air, and the aging property is quite good. A study was also made of the effect of organic halogen compounds.

Biochemistry of Latex I

Preliminary electron microscope observations on the ultrastructure of the latex vessel and its contents in young tissues of Hevea brasiliensis. E.H. Andrews and P.B. Dickenson, The Natural Rubber Producers' Research Association, Welwyn, England

Microscopy of Hevea latex. W.A. SOUTHORN, The Rubber Research Institute of Malaya, Kuala Lumpur

Eight types of particle and a thread-like reticulum have been seen in very fresh latex. Changes were observed on wintering and after resting the tree. These new observations throw light on the shape of the rubber particle and how it is formed.

Biosynthesis of rubber from C^{14}-acetate by stem slices and latex enzyme from Hevea. J.L. RABINOWITZ* and H.J. TEAS**, *Veterans' Administration Hospital, Radioisotope Service, Philadelphia; **Agricultural Experimental Station, University of Florida.

Some recent studies of the non-rubber constituents of natural rubber latex. B.L. ARCHER and A.I. MCMULLEN, Natural Rubber Producers' Research Association, Welwyn, England

Biochemistry of Latex II

The proteins of Hevea latex: ion exchange chromatography and starch gel electrophoresis. A. KARUNAKARAN, G.F.J. MOIR and S.J. TATA, The Rubber Research Institute of Malaya, Kuala Lumpur

Isolation and identification of the free amino acids in fresh unammoniated Hevea latex. NG TET SOEI, Institute for Rubber Research and Development, Bogor, Indonesia

The substrate for V.F.A. formation in natural rubber latex. J.S. LOWE, Dunlop Research Centre, Batang Malaka, Malaya

Experimental evidence is presented which suggests that the primary substrate for V.F.A. formation in ammoniated latex is a glucose-amino-acid complex. Quebrachitol does not contribute to the changes in non-rubber constituents of stored latex.

Microbiology of Latex I

Bacterial counts and their relation to volatile fatty acid content, KOH number and mechanical stability. D.H. TAYSUM, The Rubber Research Institute of Malaya, Kuala Lumpur

The techniques of viable counting on modified Kligler's iron agar, viable counts on supplemented media, total counting and revival counting are described. Some typical results are given. An attempt is then made to relate these results to control tests used in latex preservation.

It is suggested that the V.F.A. content of uninfected fresh latex is zero. Evidence is given that there is no intrinsic (non-bacterial) V.F.A. formation in ammoniated field latex (ca. 0.3% NH_3, w/w). Ammonia-

ted latex concentrate (0.7% NH_3, w/w), prepared so that no degradation by viable bacteria occurs subsequent to rapid field collection, has a V.F.A. content not exceeding 0.007, a KOH number of 0.37 after one month's storage and a mechanical stability of from 1,000 to 1,600 seconds.

Factors affecting the relationship of KOH number to mechanical stability are outlined; it is shown that the liberation of surface active agents during ammoniation, which increases the mechanical stability, results only in a very small increase in KOH number. Thus a high mechanical stability and low KOH number are attainable simultaneously. Bacterial degradation, rather than the effects of ammoniation, is mainly responsible for the high KOH numbers reported in industry.

The V.F.A. content and viable bacterial counts developed with time are followed for fresh latex, ammoniated field latex and briefly for ammoniated latex concentrate; the results indicate that the formation of volatile fatty acids is always preceded by bacterial division. It is put forward that the major requirement for arresting V.F.A. formation is thus the inhibition of all bacterial division. The rapid killing of bacteria is the only way of ensuring such an arrestment in bulk concentrate. The production of volatile fatty acids at a high level appears as a terminal shift from the normal bacterial metabolism of the Krebs cycle.

Astell roll-tube technique and its application to the testing of latex samples. R. Pepper, The Rubber Research Institute of Malaya, Kuala Lumpur

Experiments were undertaken to determine whether the Astell roll-tube technique was applicable to the bacteriological testing of latex samples. Comparisons between tubes and petri dishes were made to see if the former could be adopted in preference to the latter over certain ranges. Statistical analysis of the data showed that the results were very similar and variation between replicate sub-samples was of the same order for both methods. The advantages and disadvantages of the roll-tube methods are discussed.

Microbiology of Latex II

The establishment of a bacterial population of latex vessels during normal tapping. D.H. Taysum, The Rubber Research Institute of Malaya, Kuala Lumpur

The extent of bacterial proliferation within latex vessels has been assessed. An earlier assumption that the latex vessels of untapped young trees, free from physical damage, are sterile is shown to be correct for buddings of Tjir 1, within the limits imposed by methods of testing. The rate at which bacterial contamination develops as tapping proceeds has been studied. The numbers of bacteria occurring are influenced by the appearance of lysogenic bacteriophage.

The compass of viable infection in mature trees in normal tapping is discussed both in terms of the numbers of bacteria generated and in terms of the depth below the tapping cut to which bacterial contamination extends.

Two species of bacteria are described and an attempt made to assess the significance of their occurrence in terms of metabolites in the latex and the physical state of damaged latex vessels.

Sterile tapping systems are discussed in the light of present knowledge of bacterial proliferation. The tendency to precoagulation at the tapping cut is examined in relation to infection.

Study of some factors which may influence the development of bacteria in latex. (In French) NGUYEN HUNG CHAT, S. PUJARNISCLE and J. D'AUZAC, Institut des Recherches sur le Caoutchouc au Vietnam

Low-temperature inhibition of changes in bacterial populations and its application to testing of latex samples. R. PEPPER, The Rubber Research Institute of Malaya, Kuala Lumpur.

The effect of 'icing' on the bacterial populations in field latex, ammoniated field latex, freshly prepared latex concentrate and unammoniated latex collected on ice is discussed. A reasonably accurate picture of the bacterial population in latex immediately after ammoniation can be obtained provided the samples are iced immediately.

Recommendations are given on standardising the handling of samples prior to testing, in order to obtain comparable results.

Investigation of mould growth on sheet rubber. K.F. HEINISCH and M. NADARAJAH, The Rubber Research Institute of Ceylon

Three species of mould commonly found on Ceylon sheets, one a *Penicillium* and other two *Aspergillus* species, have been tested against several fungicides, in aqueous media and on smoked sheet, in order to find an alternative to paranitrophenol, the use of which has been disallowed in Ceylon in raw rubber manufacture. The tests showed that salicylic acid anilide and sodium-o-phenyl phenate could be considered as suitable substitutes for paranitrophenol. Phenylmercuric acetate showed a marked inhibiting effect on the growth of *Aspergillus* but very little effect on that of *Penicillium*. Sodium bisulphite and RPA. 3, chemicals used in rubber manufacture, have a noticeably delaying effect on mould growth. Growth curves of mixed infections show maxima and minima caused by changes in the composition of mould population due to changes in environment.

Factory Practice and Allied Subjects

Flocculation of latex and sèrum from centrifugation: development prospects (In French). M. LIPONSKI and VU DINH DO, Institut des Recherches sur le Caoutchouc au Vietnam

Latex can be destabilised by the addition of colloidal hydroxides. The more pronounced the colloidal characteristics of the hydroxide, the more complete is the flocculation. The best method consists in precipitating the hydroxide *in situ* in the latex. The hydroxide sets firmly on the rubber particles, preventing re-agglomeration; the water can then be run off and the resultant flocs dry much faster than normal sheet. The best results are given by aluminium hyroxide, the second best by zinc hydroxide.

Flocculation seems to result from deposition of colloidal hydroxide on the protein layer, and occurs at the same time as the normal process of destabilisation.

When aluminium salts are used, precipitation of the hydroxide can be affected either by strong bases or by salts of weak acids.

Compared with coagulation, the flocculation method has the following advantages: it is rapid, is readily adapted to mechanical handling, facilitates drying and improves yield. Compared with coagulated rubber, flocculated rubber shows the following advantages: a clear and constant colour; less variability; easier handling. Possible disadvantages are: the raw rubber is more easily oxidised at high temperature; using classical accelerators the rate of scorch is higher; it contains 1% alumina. All other properties of flocculated rubber, especially ageing of the vulcanisates, are exactly the same as those of coagulated rubber.

Flocculated rubber can be dried at room temperature using forced air circulation so that a fairly fine rubber powder can be economically prepared.

Skim latex can also be flocculated.

Progress in masterbatch technique (In French) M. Liponski and Vu Dinh Do, Institut des Recherches sur le Caoutchouc au Vietnam

When a mixture of latex and a colloidal suspension of red clay is acidified, both colloids are destabilised at the same time. An intimate mixture is obtained which coagulates more readily the higher the proportion of rubber and the smaller the particle size of the rubber. Nitrogenous substances normally eliminated into the serum are carried into the masterbatch by the clay, thus increasing the rate of cure. A control method allows the proportions of clay to be determined to $\pm$ 3%.

After machining, the coagulum dries quickly. The dry material resists oxidation well, despite the presence of manganese in red clay, if complexing agents which are also antioxidants are used.

Every red clay of basaltic origin from the rubber growing areas of Vietnam and Cambodia gives the same results.

Skim latex can be used instead of fresh latex. In this case greater amounts of clay can be introduced, giving harder vulcanisates with no loss of tear strength. However, they have a higher heat build-up than vulcanisates made from fresh latex with the same filler content.

Only clay masterbatches with natural rubber have reached the industrial level of application, but the technique can be used with other fillers.

Bubble and blister formation in sheet rubber. R.S. GALE, The Rubber Research Institute of Malaya, Kuala Lumpur

Field latex, diluted latex, and serum squeezed from coagulum all contain gas which can be liberated by stirring. This has been demonstrated by carrying out the stirring in a closed system and noting the rise in pressure. Carbon dioxide is one constituent of the gas which is liberated.

The pH of coagulation, the sheet thickness and the temperature and humidity of the drying air all influence the occurrence of gas inclusions within a sheet.

The treatment of aqueous effluent from rubber production using a trickling filter. T.V. MOLESWORTH, The Rubber Research Institute of Malaya, Kuala Lumpur

This paper describes work carried out on the purification of rubber factory effluents using a trickling filter. The results show how the organic loading and use of recirculation affect the efficiency of removal of B.O.D. (biological oxygen demand) and other components. A correlation of the results is presented and its application to the design of trickling filters for particular duties is discussed.

Rubberised bitumen from rubber-bitumen masterbatch. S. NARUSAWA, S. KUNISAWA and M. ASAO, Foundation for Natural Rubber Research and Development, Japan

It has been proved that rubberised bitumen is a superior paving material, and numerous investigations have been carried out on the properties of rubberised bituminous cements and their mixtures. No rubber so far used for this purpose has been found suitable. For instance, latex and the rubber powder made from it are too expensive, and scrap rubber from tyres and other rubber goods is not sufficiently dispersible in bitumen.

As a result, rubber-bitumen masterbatches, in which low-grade raw rubber such as flat bark and remilled earth scrap can be used, were tried as one of the types of rubber apparently most suitable for this purpose. Eighty parts by weight of flat bark premasticated to a Goodrich plasticity of about 0.7 (100°C) were mixed with 20 parts of straight-run bitumen 40/60 and 5 parts of powdered oxalic acid on an open mill, and the mixture was used as a rubber-bitumen masterbatch for rubberising bitumen. The properties of rubberised bituminous cement from this masterbatch were also studied. The effects of sulphur on ductility and tenacity are discussed.

Developments in engineering applications of rubber. A.N. GENT, P.B. LINDLEY and L. MULLINS, Natural Rubber Producers' Research Association, Welwyn, England

There is a general difficulty experienced in designing rubber components, due either to the absence of necessary basic information or to

its non-availability in a suitable form. Recent studies which have gone some way towards remedying these deficiencies are discussed. They show how the stiffness of rubber components depend on their shape, size, temperature, mode of deformation and on the nature of the rubber compound. They also provide an understanding of the sources of failure likely to occur in service and of methods of preventing premature failure. With this information, it is now possible to undertake the basic design of rubber components for a wide range of engineering applications without recourse to a completely empirical approach. Recent and novel uses of rubber in civil engineering involving the application of this knowledge are described. These involve its use in bridge bearings and rail fastenings.

The technical merits of rubber as an additive to road binders: the present position. L. MULLINS, Natural Rubber Producers' Research Association, Welwyn, England

Small quantities of rubber produce large changes in the physical properties of bitumen and these in turn are reflected in the behaviour of road mixtures. The effects are influenced considerably by the kind of rubber and the method of adding it to the road materials.

The results of a systematic examination into the relative effectiveness of different kinds of rubber are described. In addition, the organisation and execution of large scale road experiments carried out during recent years in Great Britain are discussed. It is emphasised that for such experiments careful design is essential, involving the inclusion of adequate control sections, the close control of variables such as the state of the rubberised binder, the temperature and time of mixing, and spreading technique. The results obtained from these trials and their implications are described.

R. R. I. News

At the request of the Government of India and the Ministry of Commerce and Industry of the Federation of Malaya, the R.R.I.M. sent a party of officers to India in April 1960, to advise on immediate and long term means of improving the production of natural rubber there. The party was made up of Dr Newsam, Head of the Pathological Division, Mr Brookson, Head of the Botanical Division, and Dr Watson, now Head of the Soils Division. They spent a fortnight in Kerala and Madras States of India and their report is now with the Government of India.

The contents of the report are confidential so far, but it can be said that in general the party found the condition of rubber cultivation on estates to be good, considering the adverse climatic conditions prevailing in most of the rubber growing areas. The heavy monsoon in these areas favours the development of severe attacks of *Phytophthora palmivora* leaf fall disease, and research into the control of this disease occupies a prominent place in the programme of the Rubber Research Institute of India.

Following a request from the Nigerian Government, an advisory team of three officers from the R.R.I.M. visited Nigeria for a period of two months in November and December, 1960. The task of the team, which consisted of Mr C.W. Brookson (Head of the Botanical Division), Mr J.E. Morris (Advisory Officer for the Chemical Division) and Mr Wong Mun Yun (Assistant Smallholders' Advisory Officer), was to advise the Government of Nigeria on the development of a programme of research for the rubber plantation industry.

After visiting Nigeria, Mr Wong Mun Yun spent approximately three weeks in Britain, studying advisory organisations, and Mr Morris spent one week in Liberia visiting the Firestone plantations.

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The field staff of the Smallholders' Advisory Service now comprises 23 Rubber Instructors, 116 Assistant Rubber Instructors and 10 Rubber Demonstrators.

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Mr Yeoh Chong Hoe, B.Sc. (Agric.), joined the Smallholders' Advisory Service on 1 November 1960 as Assistant Smallholders' Advisory Officer, Division 'B'. Mr Yeoh is a graduate of the College of Agriculture, Serdang, and holds the degree of B.Sc. (Agric.) from Reading University.

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Mr John Bosco Gomez, B.Sc., joined the staff of the Botanical Division as Research Officer, Division 'B', on 12 September 1960. He obtained his Bachelor of Science degree in Botany at Kerala University in 1958 and worked as a Science Master at Clifford School, Kuala Kangsar, Perak, for about a year. Mr Gomez is to carry out investigations on the anatomy and morphology of *Hevea*.

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Mr Shyamal Kumer Majumder, M.Sc., joined the staff of the Botanical Division as Cytogeneticist, Research Officer Division 'B', on 3 October 1960. He obtained his Bachelor of Science (Honours) degree in Botany at Calcutta University in 1958 and subsequently worked for two and half years under Dr A.K. Sharma D.Sc., Professor of Botany, studying cytogenetics for his Master of Science degree. His work at the Institute includes cytological investigations on clones used in the breeding programme, measurements of pollen tube growth, determination of pollen fertility and sterility, and other allied work on *Hevea*. He will also examine abnormalities in clones made from colchicine-treated and irradiated seedlings.

Proceedings of the Natural Rubber Research Conference

As explained in the leaflet issued with *Planters' Bulletin 51*, the *Proceedings* will be available, early in 1961, as a single bound volume containing over 1,000 pages. All technical papers and discussions are reported in full. The price will be $23.00 (Malayan), plus cost of postage and packing as follows: $1 within Malaya; $2 (book post) or $5 (parcel post), outside Malaya. To be certain of obtaining a copy, readers should order now.

Courses for Senior Estate Conductors

Refresher courses for senior estate conductors are offered this year at the R.R.I. Experiment Station during 17 to 21 April, 15 to 19 May, 19 to 23 June and 16 to 20 July. Twelve conductors can be taken on each course; they must be senior experienced men who are actually in employment, and all applications must be made by the managers of the estates concerned.

The programme will be mainly field work. Demonstrations, talks and lectures will include replanting and new planting procedures, weed control, establishment of legume covers, budgrafting and care of young budgrafts, pests and disease treatments, manuring, tapping systems, yield stimulation and a brief outline of factory procedure.

Please apply early, to the Director.

Secondary Leaf Fall

As explained in *Planters' Bulletin 46* of January 1960, the annual circular requesting a report on the incidence of secondary leaf fall is no longer being distributed. However, the Institute will be glad to examine and report on any leaf specimens of this disease that may be sent in. Affected leaves and flowers should be collected from the branches, not gathered off the ground, and should be sent to the Institute pressed between pieces of dry newspaper. Please number the specimens serially, and indicate on a separate piece of paper the serial number, area affected, and age of the trees. It is also important to inform us whether the material consists of unselected seedlings, clonal seedlings, or buddings (stating which clone) and whether the attack is severe, moderate or slight.

OUR COVER PHOTOGRAPH SHOWS 'THE INTRODUCTION OF BUDGRAFTING', ONE OF THE TWELVE PAINTINGS ILLUSTRATING THE HISTORY OF THE RUBBER INDUSTRY IN MALAYA, WHICH WERE DISPLAYED IN THE TUNKU ABDUL RAHMAN HALL, KUALA LUMPUR, DURING THE 15TH MEETING OF THE INTERNATIONAL RUBBER STUDY GROUP AND SUBSEQUENTLY DURING THE GENERAL SESSIONS OF THE NATURAL RUBBER RESEARCH CONFERENCE.

The Standard Engravers & Art Printers, 63 Campbell Road, Kuala Lumpur, Selangor